


# Capacity Building K–12

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The development of the whole person is central to every student's school experience, inside and outside the classroom, including the time they spend online.

This monograph suggests ways that educators can enhance students' well-being and foster both their sense of self-worth and efficacy while helping them learn in the mathematics classroom.

 If you are reading this monograph in print and want to access the hyperlinks, go to [www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/math\\_classroom.html](http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/math_classroom.html)



Capacity Building Series  
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## Yes, I can!

### Paying Attention to Well-Being in the Mathematics Classroom

*“One of the most damaging mathematics myths propagated in classrooms and homes is that math is a gift, that some people are naturally good at math and some are not.”*

(Boaler 2013a, 2013b)

### There is No Such Thing as a Math Gene

You've probably heard it before – “I'm not good at math” or “I don't have the math gene.” Teachers say it, parents say it, and not surprisingly, students say it. You might have even said it yourself.

This perception becomes a problem when students attribute their success – or poor performance – in mathematics to ability and not to effort (Sutton & Kruger, 2002). Indeed, the notion makes it pretty easy to dismiss poor results as something beyond one's control, whether one is a student or teacher. And yet, we know from science that there is no such thing as a math gene (Depenbrock, 2017).

Attitudes to mathematics in fact are learned – not inherited – and they can be learned and unlearned, too. This monograph suggests some ways to do precisely that – by creating

a learning environment in the mathematics classroom that encourages students to learn from mistakes, to persevere in overcoming challenges and to recognize and enjoy success.

### The Link between Attitudes and Achievement

Researchers have established a clear connection between the attitudes that students have towards mathematics and how well they perform mathematically. For example, Pajares and Kranzler (1995) found that the belief that one is capable of doing mathematics (self-efficacy) is a better predictor of senior mathematics achievement than is prior math achievement. Similarly, Bruce and Ross (2010) established that Ontario students' belief in their mathematical abilities is an important determinant of their achievement.



Interestingly, most students like mathematics when they first start school. Many Kindergartners delight in impressing their educators by how high they can count, for example. Yet over time, positive attitudes about mathematics decline.

What is it about school mathematics that results in this shift in attitude? What leads students to believe that they can't do math and aren't good at it?

Researchers have concluded that what often gets valued in mathematics classrooms is precisely what turns many students away from mathematics. When students begin to believe that mathematics is only about procedures, memorization, and being "quick" to be good, their confidence is shaken – especially if these things do not come readily to them (Boaler, 2009).

*“I was always deeply uncertain about my own intellectual capacity; I thought I was unintelligent. And it is true that I was, and still am, rather slow. I need time to seize things because I always need to understand them fully. Towards the end of the eleventh grade, I secretly thought of myself as stupid. I worried about this for a long time.”*

Laurent Schwartz, Mathematician  
(Fields Medalist, 1950)

An emotionally charged relationship with mathematics is likely to impact academic and life choices. Researchers have found that students who enjoy mathematics tend to perform well in their mathematics courses and are more likely to enroll in more advanced mathematics courses down the road. This choice has significant implications for career possibilities, workplace mobility and even day-to-day decision-making. Conversely, students who dislike mathematics tend not to do well in their math courses and are more likely to opt out of more advanced courses in secondary school (Sutton & Kruger, 2002). All of this reinforces the importance of

instilling in students an understanding of the value of learning from mistakes, trying and persevering, and recognizing success as it is experienced.

## We Can All Be “Math People”

So what makes a person identify as a math person? In a study of more than 9,000 college calculus students, researchers found that belief in one's competence and performance was a factor. But it was secondary to interest in the subject and recognition from others – teachers, parents, relatives or friends – that they had capacity and potential to do well in mathematics (Tejedor, 2015).

In her study of four high-performing Grade 9 Applied Mathematics classrooms, Macaulay (2015) found that many students began the course with a fractured relationship with mathematics and mathematics learning and a poor sense of themselves as math learners. Their teachers made it a priority to build student confidence and saw their first order of business as helping students see themselves as capable and competent people *and* as capable and competent math learners. Once students began to think of themselves in this way, they began to thrive in the classroom.

This illustrates the critical importance of getting to know the strengths and needs of students first, and of believing in the capacity of all students to learn as the starting point for planning instruction.

*“As we continue to strive for excellence in our education system, we know it is essential to help all of our students develop a sense of well-being – the sense of self, identity, and belonging in the world that will give each of them their best chance to learn, grow and thrive.”*

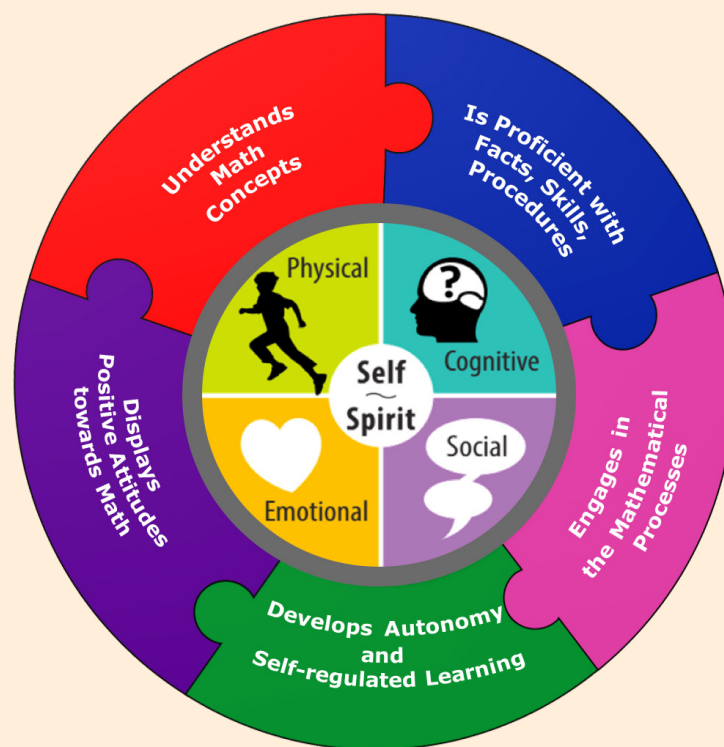
(Ontario Ministry of Education, 2016)

## Ontario's Vision for the Mathematics Learner







In Ontario, we recognize that the study of mathematics equips students with knowledge, skills, and habits of mind that are essential for successful and rewarding participation in society. The ministry's vision for the mathematics learner recognizes that students need classroom experiences that help them to:

- **develop math understanding**
- **learn important facts, skills and procedures**
- **develop the ability to apply the processes of mathematics**
- **acquire a positive attitude towards mathematics**
- **build autonomy as a math learner**

Each piece of the puzzle is important in supporting the development of mathematical thinkers and doers, and the belief that one is mathematical. At the heart of this vision is the well-being of the student.



In a broad-based provincial engagement with students, parents, educators, staff and stakeholders, it was affirmed that student well-being is shaped by a child's whole experience at school and that students want to be supported to develop and experience:

- |   |  |
|---|--|
|  Sense of Self and Spirit      |  Meaningful Learning      |
|  Physical and Emotional Safety |  Supportive Relationships |
|  Sense of Belonging            |  Healthy Minds & Bodies   |

For more information about well-being in Ontario schools [click here](#).

## Nurturing Well-Being and Mathematics in the Classroom

How can we construct an environment that will help students feel safe and enjoy learning? In the ministry's **province-wide engagement on student well-being**, feedback from students, educators, parents and others in the community was conclusive – they identified the importance of caring relationships, a sense of self/identity, a feeling of connectedness and belonging, and the importance of meaningful learning as well as attention to healthy bodies and minds and physical and emotional safety. They urged that all of this needs to be nurtured in students' day-to-day experiences in school, including in mathematics class.

Being mindful of the kind of experiences students are having in math classrooms and putting the emphasis on learning – not performing – can make an impact on changing attitudes and helping students become ready to learn. When students have heightened performance anxiety, their brains are not open to new learning, which in turn affects processing skills and working memory (Young, Wu & 2012). Hence, it is important to establish a classroom climate that reduces anxiety and promotes the belief that all students can be capable and confident when it comes to math. With less emphasis on right or

wrong, and more emphasis on process and learning, anxiety about math can be kept in balance. Limiting anxiety and pressure about getting the right answer tends to alleviate some of the worry and allows students greater freedom in exploring their thinking processes and their problem-solving abilities. This can inherently build confidence by highlighting all they do know (i.e., their strategies for thinking through the problem) in addition to the final answer.

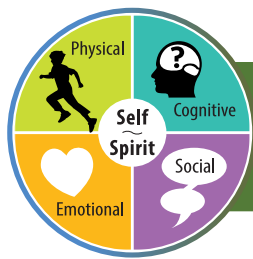
Yet research also shows that when students make mistakes, synapses fire and brains grow (Boaler, 2014). Some frustration is healthy and helps with brain development. Educators can help students in recognizing and accepting some level of frustration as part of the learning process and recognizing the need for strategies or help-seeking for levels of frustration that are not productive.

Educators can help students strive to find the level of optimal challenge for themselves. This is sometimes referred to as "flow." Flow is "deep absorption in an activity that is intrinsically interesting. Individuals in a state of flow see the activity as worthwhile even if no further goal is reached. Flow is believed to occur at the point of balance between the challenge inherent in the task at hand and the skills required to accomplish it" (Csikszentmihalyi, 1997).



### Tips to Reduce Math Anxiety for Students

- Students learn best in an environment where they are encouraged to try and when they are in a calm emotional state. So, eliminate surprise or timed tests and calling on students who don't raise their hands to respond.
- Teach and encourage the use of everyday strategies like relaxation or deep breathing to reduce stress. Even something as simple as mindful breathing and positive intentions can help settle nerves before approaching a task that is perceived as challenging.
- Provide reassurance for students to ask questions or ask for help if needed.
- Help students understand that challenges are an expected part of problem-solving and learning, and that sometimes our most creative thinking comes from persevering through frustrations and difficult situations.
- Focus on the development of a growth mindset and emphasize *process over right or wrong answers*; a "wrong answer" isn't "bad," but simply an opportunity to learn.
- Establish a shared understanding that we all make mistakes and highlight that we can learn from examining mistakes.



# Inspiring Stories: Making the Mathematics Well-Being Connection

Many schools and school boards across the province have been exploring the important connection between learning and well-being and in particular how a focus on well-being in the mathematics classroom can help students overcome negative attitudes and experience success. Here we share the highlights of three recent provincial inquiries together with key reflections from educators who have been engaged in this work.



## Nurturing Student Mental Health in the Mathematics Classroom

Excerpted from T. Lindstrom, *Key learnings from Nurturing Student Mental Health and Well-Being in the Mathematics Classroom at Keewatin-Patricia District School Board* (2017)

In 2011, as part of the Ontario Mental Health and Addictions Strategy, the Ministry of Education funded the creation of School Mental Health ASSIST (SMH-ASSIST), an implementation support team. Stemming from the work of Dr. Kathy Short, director of SMH-ASSIST and her team, a group of administrators and mental health leads from across the province came together to support principals everywhere in *Leading Mentally Healthy Schools (LMHS, 2013)*.

As we focused in on the Grade 7-10 math classroom, we linked to the LMHS work and our learning can be

summed up as “purposeful planning for learning opportunities.” This means:

- We know our students (relationships).
- We understand (through assessment) where our students are beginning, i.e., their learning strengths and gaps.
- We plan with our students in mind, knowing where our curriculum is taking us.
- We create the conditions for learning that support achievement, equity and well-being for all students.

This is no small task and many of our educators are working very hard to decrease the prevalence of students experiencing anxiety and to increase the ability of students to persevere with mathematical problems.



## Helping Students Persevere with Mathematical Problems

While our work is in the early stages, some of the strategies we have employed include:

- planning effective questions and designing tasks that show understanding of the concept as well as process
- slowing down in order to increase confidence, competence and allow students to feel dignity in their learning journey
- predicting student responses so that we can anticipate questions and prompts that will promote student learning and affirm what they know and can do
- helping students to understand that there may be more than one way to solve a problem, but also that some ways are more efficient than others
- providing the tools (manipulatives), strategies (pictorial problem solving, observations, algorithms), and opportunities (conferencing, discourse, discussion) that promote a deeper understanding of the concept or number sense
- opening conversation and professional learning around what good math instruction looks like



## The Well-Being/Mathematics Inquiry

Excerpted from J. Vieira and P. Williams, *Key learnings from Well-being and Math System Inquiry at Dufferin-Peel Catholic District School Board* (2017)

As part of our board's strategy to make setting Catholic conditions for learning and leading more explicit in our schools, the Program Department supported a system inquiry focused on learner well-being and mathematics. A cross-discipline team was established to support the inquiry and included staff from the departments of Mathematics, Staff Development, Religious Education & Faith Formation, Research, Special Education & Support Services, Equity & Diversity, as well as administrator and teacher representation from a cross-section of participating schools.

*We wondered:* "If we explicitly focus on the well-being of all learners in the context of mathematics, what might the impact be on student learning and the development of mathematical understanding?"

We chose to concentrate on the components of well-being that a school might have the greatest impact on – feelings of respect, acceptance, a sense of safety to take risks, personal value, sense of voice and contribution, and sense of belonging to a community.

Critical to the inquiry was the application of the work in schools (including summer school) using a case study approach. We discovered a parallel impact of our focus on well-being on educators and students, as highlighted in the chart below:

*“What I enjoyed the most about co-learning was my learning from the teachers and their learning from me or our class ... what I enjoyed the most was doing or working on problems with partners ... we learned how to work together.”*

Student, Dufferin Peel Catholic District School Board

### Key Learnings of the Inquiry Over a Five-Year Period

System and School Application with Educators	Classroom Application with Students
<ol style="list-style-type: none"><li>1. A community of co-learners is built over time by fostering relationships where educators “feel safe to be vulnerable” and take risks as they learn.</li><li>2. A <i>co-learning stance</i> is an essential component for developing a professional learning community in mathematics.</li><li>3. Educators need to see themselves as co-learners and be willing to:<ul style="list-style-type: none"><li>• exchange learning and insights within and between roles</li><li>• engage in focused conversations about learning</li><li>• ask thoughtful questions and reflect on current practice</li><li>• come to common understandings about instructional and collaborative practices</li></ul></li><li>4. Well-being is essential to moving mathematics learning forward; educator well-being matters.</li></ol>	<ol style="list-style-type: none"><li>1. Time is needed to build a community of mathematicians, and to foster relationships, so that students feel safe to take risks and make mistakes as they learn.</li><li>2. Students and teachers need to be given the opportunity to collaborate in order to see themselves as co-learners.</li><li>3. The co-construction of learning by students and teachers is essential to a positive learning environment, class discourse in math, etc.</li><li>4. When students and teachers co-construct what well-being in mathematics looks like, sounds like and feels like, well-being becomes visible in classrooms (e.g., self-directed students, happy faces, laughter, respectful disagreements, students feel like they matter).</li><li>5. Student voice and self-reflection are key components to understanding oneself as a learner.</li><li>6. Student self-assessment is linked to student well-being.</li></ol>



## Teaching Grade 9 Applied Mathematics

Excerpted from C. Suurtamm, *Research report. Teaching Grade 9 Applied Mathematics. A Collaborative Inquiry* (2017)

The Ministry of Education provided funding to the Ontario Association for Mathematics Education (OAME) to follow educator teams in nine schools that were focused on enhancing the learning and teaching of Grade 9 Applied Mathematics. These teams were followed by researchers from the University of Ottawa over a two-year period.

Most of the teams started on their journey with the goal of increasing student engagement. Participants discussed the negative ways students often approach learning in mathematics, typically after years of being unsuccessful and/or having negative experiences in the subject. Most professional learning communities realized that in order for students to be successful it would be important to create a positive environment where students felt comfortable to take risks and make mistakes.

Much of their focus over the two years concerned the implementation of practices that would better engage their students. These practices included fostering growth mindset; using vertical non-permanent surfaces (VNPS) and visibly random groupings; assigning rich tasks; increasing the use of technology; and reorganizing the curriculum sequence to help students achieve early success. Perhaps most importantly, attention to the emotional needs of students was identified by some educator teams.

“The students were starting to see themselves as successful mathematics students, particularly when they had problems that they were allowed to approach in many different ways. The teachers suggested that the development of tasks with multiple entry points (i.e., multiple approaches that are accessible for different ability levels) made mathematics accessible to a wider range of students. The Grade 10 Applied Teacher said she received a phone call from a parent who thanked her for what she was doing, as her son now seemed so excited about mathematics.”

(Suurtamm, 2017, p. 38)



### Making the Well-Being Connection

The researchers identified other recommendations which are linked to student well-being (cognitive, social, emotional, physical domains):

- **Focus on the student together with the curriculum.** The “verbs” of the curriculum together with the strengths, needs and interests of the students should drive what students do in the classroom – e.g., students will *explain, solve, determine* etc.
- **Provide an engaging and safe space to take risks.** Work with students to describe and design what that safe space looks like and sounds like.
- **Engage students in rich tasks and problem solving.** Have students work collaboratively to solve problems and then explain their mathematical thinking.
- **Use a variety of assessment strategies.** Provide multiple opportunities and means for students to demonstrate what they know and can do.
- **Have high expectations for all students.** Let all students know that you believe in their potential, including their mathematical potential.

# Some Final Considerations for Fostering a Supportive Math Learning Environment

- Create a community of mathematics learners that includes the educator.
- Insist that we are all “math people” and seek examples to show practical examples that illustrate this.
- Value the thinking that all students bring to the classroom.
- Help students to appreciate that errors and failed attempts are opportunities for learning and have value.
- Focus on understanding so that students recognize that mathematics must always make sense to them.
- See the student as a whole person, paying attention to all developmental domains when planning instruction, assessment and learning (e.g., provide opportunities to move while learning, plan for supportive social interactions, consider emotional impact of instruction).
- Make learning the goal by supporting every student in playing an active role in his/her learning.
- Be careful about offering unsolicited help, and especially only targeting low achievers for assistance. Listen to each student about his/her goals and needs.
- Provide cognitively challenging tasks and take the students’ strengths, needs, interests and views into account when planning learning opportunities.
- Provide timely and descriptive feedback that will help students to improve.
- Inspire students to see math in the world around them.

*Above all, have fun! Enjoy the beauty and wonder of mathematics!*

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